

constant may involve a very different constant from that which, with small modification, applies to the three known radioactive families. Still more fundamental would be the discovery of some other than a radioactive origin for these haloes. I have considered many alternatives. One naturally thinks of a chemical influence emanating from the nucleus. Apart from the difficulty of accounting for the consistent measurements, the existence of bleached haloes in this mica, which possess the characteristic dimensions of uranium and emanation haloes, seems a formidable difficulty. The relation between the radioactive staining and the bleaching is everywhere such as to suggest that the latter is a modification of the former. A quantitative difficulty also exists. The volume of the nucleus varies from the $\frac{1}{150000}$ to the $\frac{1}{1500000}$ part of the halo-volume which it has affected. Yet the nucleus may be a limpid particle revealing no trace of loss or decomposition. Only radioactivity can confer on one atom the energy requisite to ionise many hundreds.

Of course some one of the known elements may be responsible for these haloes. Geiger and Nuttall long ago pointed out the difficulty which would attend the discovery of radioactivity in elements having a radioactive constant proportional to such ranges. But here we have an integration such as far transcends the resources of the laboratory. Until this point is settled—if it ever will be possible to settle it—a distinguishing name seems desirable. To this name the addition of numerals would suffice to deal with such halo-developments as may be ascertainable.

J. JULY.

Trinity College, Dublin, April 25.

Pythagoras's Theorem as a Repeating Pattern.

THE interesting communication from Major MacMahon on the above subject reminds me of a proof which I discovered over the chessboard a few years ago, of the well-known fact, that if the lengths of the sides of a right-angled triangle are 3 and 4, the length of the hypotenuse will be 5.

Placing pawns at A, B, and C (Fig. 1), we require to prove that A is equidistant from B and C. We put

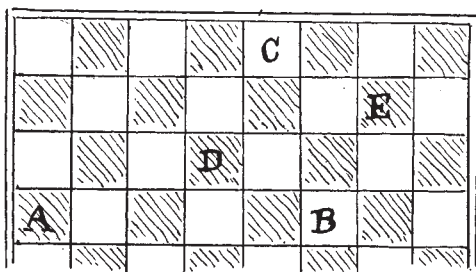


FIG. 1.

two more pawns at D and E, when it will be readily seen, even by a person unacquainted with Euclid, that A, D, E are in line and that CEED is a square. Since any point on a diagonal of a square must, by symmetry, be equidistant from the extremities of the other diagonal, $AB = AC$.

The corresponding general proof of Pythagoras's theorem is as follows. Given $x^2 + y^2 = z^2$, we get

$$\frac{z+x-y}{x+y-z} = \frac{x+y+z}{z+y-x} \quad (1)$$

by algebra. Taking horizontal and vertical axes of reference through an origin O (Fig. 2), we mark down a point A the co-ordinates of which are $\frac{1}{2}(z+x-y)$, $\frac{1}{2}(x+y-z)$, and a point B the co-ordinates of which are $\frac{1}{2}(x+y+z)$, $\frac{1}{2}(z+y-x)$. By the given relation (1) OAB is a straight line. Through A and B draw ordinates PQ,

SR, each equal to PS, and in the square PQRS inscribe the square ADBC by marking off $RD = PC = SB$. Then, drawing the ordinate DN, we have

$$DN = PS = \frac{1}{2}(x+y+z) - \frac{1}{2}(z+x-y) = y,$$

$$ON = OP + PA = \frac{1}{2}(z+x-y) + \frac{1}{2}(x+y-z) = x,$$

$$OD = OC = OP + SB = \frac{1}{2}(z+x-y) + \frac{1}{2}(z+y-x) = z,$$

which proves the theorem.

It is to be noted that in any special case where x, y, z are given integers (as in the case given above), it can be easily shown that OAB is a straight line

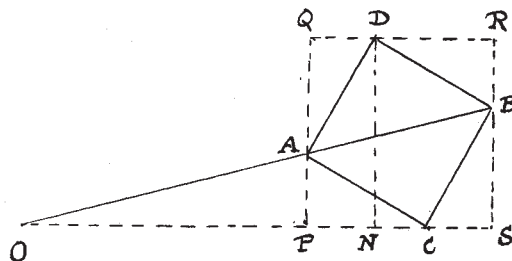


FIG. 2.

without knowing anything about proportion. Thus in such cases Pythagoras's theorem is proved without introducing areas. It has, I believe, been suggested that the ancient Egyptians must have been acquainted with Pythagoras's theorem, since they knew that a triangle with sides 3, 4, 5, is right-angled. But they may possibly have known only the special proof here given.

Lastly, it may be noticed that Euclid's axiom about parallels is tacitly assumed when we allow that a repeated pattern of squares can be constructed.

J. R. COTTER.

Trinity College, Dublin, April 15.

Man.

MAN is a social animal through habit, not instinct. Religions, morals, taboos, customs, conventions, which he learns through imitation, supply him with rules of thought and conduct. Without them human society could not exist. But there are two sorts of rules. The one kind binds the body, limits action, supplies rules of conduct, and impels men to "play the game" fairly. The other sort binds the mind, limits thought, impels men never to question the rules. *When the rules that bind the mind are many and strait, men tend to regard lightly the rules that bind to conduct.* All this may seem far-fetched, but consider universal history. Is it not the fact that communities have been inefficient, stagnant, and turbulent in proportion as their minds have been bound?

I may be afflicted with racial prejudice, but to me it seems that the men of English speech owe their predominant position in the world to the fact that they more than others "play the game" scrupulously, and yet have been freest of all in their thoughts, and so, while obeying their existing rules, have most readily altered the rules both of conduct and of thought. We English may have only one sauce, but, fortunately, we have a hundred heresies. Modern English history tells of continuous evolution, but of only one revolution. Compare the histories of more orthodox countries. Men cannot get away from habit, and mental habits depend not so much on the things that are learned as on the way in which they are learned. Through imitation we get emotional convictions and closed habits of mind; through curiosity, intellectual convictions and open, reflective habits of mind. When a man is mentally "too old at forty" his mind has been artificially closed. It can no longer profit from experience.

He has become unintelligent. Consider the unlike results which would follow the teaching of science on the grounds of faith and of evidence. In the former case there would be stagnation, passionate and unending controversy, with deference to this authority and hatred of that; in the latter case, contempt for mere authority, efficiency, progress, cool discussion, and ultimate agreement. Always it is not so much the thing that is taught that matters, but the way in which it is taught, through imitation or through curiosity. Consider how inefficient were such nations as Russia and Turkey in the late war, and how they are smashed beyond repair. Had the peoples of the world been less prejudiced and more intelligent there would have been no war. The subject is immense, and desire for compression has made me didactic; but readers of NATURE may fill lacunæ, and perhaps forgive my manner.

Men learn, through imitation, unlike standards. Among us are people who regret the Dark Ages: as before them there were doubtless those who regretted the manly times of Saxon piracy, and before them those who grieved for painted savagery. But, obviously, if we desire intelligence, efficiency, a contented and prosperous population, and a progressive civilisation, we must teach our youth as much as possible through evidence. We cannot help imparting some things through imitation (*e.g.* our ideas of right and wrong), but our special aim should be to create through curiosity an open, reflective habit of mind. This is, of course, the way in which science has been created, and which its workers constantly advocate. But it is vain to express mere opinions. Many people who professedly, indeed sincerely, seek the same ends think it primarily essential to close the mind to evil by teaching especially the emotional convictions they may happen to hold, and to expend the rest of the pupil's time by causing him to learn through labour other things (*e.g.* languages) which are commonly acquired through imitation. A man may learn all the languages in the world and yet not part from a single prejudice.

Fortunately, the history of society furnishes crucial examples in abundance. For example, the modern world, like the Græco-Roman, but unlike every other, has been prolific in men great in thought or action. In these two worlds men have learned especially through curiosity. With very rare exceptions, only Christians (who more than others have abandoned mere imitation) have produced great men; and among Christians great men have been almost limited to the less orthodox (*i.e.* less imitative) sects, or to defaulters from the more orthodox. Consider Newton, Darwin, Napoleon and his contemporaries, Garibaldi, Bismarck, and the rest. The crime-rate of modern communities, ranging from civil war and rebellion, through brigandage and murder, to acts of petty violence, is immensely higher among the more orthodox, who, both peoples and individuals, usually occupy inferior positions and attribute their misfortunes to oppressors, native or foreign. But emigration to other lands leaves such people unchanged, as witness the alien population of Great Britain and the United States, with its emotionalism, tendency to corruption, and high crime-rate. Government by the orthodox is invariably corrupt or inefficient, or both, as in Russia, Turkey, and medieval England.

Efficient modern Governments, hoping to obtain peace, are often pathetically anxious to confer self-government on the orthodox. But you cannot make a silk purse out of a sow's ear. As object-lessons, compare Russia and Germany in defeat. The latter, wrecked by an emotional despot and his Byzantine Court, is cleverly reconstructing her prosperity.

Russia was, and is, and will long continue, an autocracy or lapse into chaos. People with the degree of intelligence permitted by the Orthodox Church could not possibly evolve a free and orderly State. Consider all the nations of the world. Invariably you will find that the men whose rules limit thought are inferior to those whose rules, relatively speaking, limit only action. Many empires have perished in the past from internal decay or external pressure. In the former case the decay has always coincided with an increase of training through imitation; in the latter, rival nations have increased their training through curiosity. We may confer self-government on populations in India, Egypt, and nearer home; but very certainly these populations will then only reproduce societies like those which people similarly trained have produced elsewhere.

Science has endowed humanity with a vast command over Nature, but has been less successful in establishing the scientific spirit. Within the limits created by his prejudices, facts may be taught to the adult, but frames of mind, as a rule, only to the very young; and science has neglected to consider the education of the latter. It is one thing to discover the shape and age of the earth or the origin of species, and quite another thing to persuade men already biased to accept the intellectual consequences. It is one thing to invent explosives and aeroplanes, and quite another thing to make men, already made creatures of emotion through imitation, tolerant, reflective, open-minded, rational, so that discovery shall not be used for evil. The world is seething with passionate hatreds, the offspring of prejudices, which are derived from imitation. Consider the moral and religious differences which are indelibly impressed on the minds of children, and are the root-causes of nearly all the trouble that ferments from Galway to Singapore. Knowledge, the child of Science, has outgrown her twin Wisdom, and in the hands of violent and intolerant men may easily bring our civilisation to ruin. Consider ancient Rome and how exactly her decline coincided with the rise of fanaticism. Compare, as revealed in their literatures, the minds of the fervid saints with those of the common-sense pagans. But at least we may try to guard our own land. We have a unique opportunity; for among the British, the least prejudiced of moderns, are many who would accept crucial evidence concerning the development of society if it were offered fearlessly and insistently, and only the followers of science can so offer it. The main difficulty lies in the beginning: it will be hard to move scientific men, especially biologists, to action. From the nature of their training they lack enthusiasm (which is an emotion), and therefore organisation, and therefore power. Compare Salvationists. The little finger of General Booth is thicker than the loins of the president of the Royal Society. But probably, were the movement in favour of a right method of mental training well started, the laity would supply the enthusiasm. However, all that is on the knees of the gods.

I now conclude my letters to NATURE. They may, perhaps, have achieved some small success in things about which I care little, but probably none at all in the things about which I care much. I think they have been misunderstood. I am not wildly concerned about biological terminology *per se*, or about chromosomes, or whether groups of naturalists limit their facts to those furnished by zoology and botany, or experiment, or biometry, and so forth, or whether they bring a wider range of evidence from other sciences and studies into court by means of crucial testing. If the public be uninterested or stupid, it matters not how biologists divert themselves. If it be interested and intelligent, it matters supremely; but

in the latter case biologists will be compelled, by pressure from outside, especially from the followers of other sciences, to adopt the right methods, whatever they may be. But I am concerned with mind and education, and the moment one tries to reach bed-rock in such matters one finds oneself in biological quicksands. One is told that some characters are innate and some acquired, but not the distinction between the innate and the acquired. It is understood that things that are learned are acquired, but apparently no one has tried to ascertain how much is learned or how it is learned. Seemingly, all biologists are agreed that, in themselves, acquired characters are trifling things; but while Lamarckians think them important through their cumulative effects, neo-Darwinians, conceiving them as transient, think them unworthy of study. Both parties mean one thing when they apply the word "inherit" to "innate" characters, and the exact opposite when they apply it to "acquirements."

Man is the educable animal, say some biologists. He is not educable, say (in effect) others who declare that in his mental make-up nature is four, perhaps nine, times more potent than nurture. One admires the precision of statement, but wonders what is meant. As I understand it, man's nature is such that he is particularly responsive to the nurture of mental use. It is as if a physicist had stated that the steam is four, perhaps nine, times more potent than the engine. And so on. Meanwhile, prejudice controls education and society flows towards the cataracts. I may be very ignorant as to facts and mistaken in my opinions, but in that case my demolition should be a holiday task to the trained and learned intellect. Failing demolition, I cannot help believing that biologists do not realise how very great their science is, or might be, and how vitally and immediately important their labours are, or should be. Incidentally, I have sought in these letters of mine to indicate the high importance, as it appears to me, of classifying characters, not as innate and acquired, but, as physiologists do, according to the stimuli which cause them to develop. So far as I am able to judge, unless scientific men ascertain precisely how mental characters are developed, and then vigorously apply their knowledge for the betterment of education, modern society will soon be on the rocks.

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Configurations of Molecules of Benzenoid Substances.

PROF. ROBINSON'S remarks (NATURE, April 15, p. 476) on Sir William Bragg's representation of the naphthalene molecule, as it occurs in crystals, lead me to invite attention to results obtained recently by Mr. G. H. Christie and myself. In a paper which will be published in the forthcoming number of the *Journal of the Chemical Society*, the resolution of *trans*-6:6'-dinitro-diphenic acid into optically active components is described. This, with the fact that an apparently homogeneous brucine salt has been obtained from the *cis*-form of the acid, indicates that in the separate molecules (as distinguished from their crystalline aggregates, to which Sir William Bragg's results apply) of these compounds the two benzene nuclei are not coplanar.

If this be so, it follows that the direction of the valency of each of the carbon atoms through which these nuclei are united is not, as represented in the usual formulæ for benzene, exerted in the plane of the benzene ring, and further, that this condition is astable one rather than a phase of an oscillation of

the type referred to by Prof. Robinson. It may be possible to determine to what extent, if at all, this stability involves a modification of the normal benzenoid properties associated with two benzene nuclei. Differences between diphenyl itself and benzene in respect of their molecular refraction, and behaviour on catalytic reduction and towards ozone, are already on record, so that it will also be pertinent to inquire whether the fixity of configuration is a general property of diphenyl derivatives, or is dependent on the nature of the substituents present, and connected, for example, with the observations of Baly and Collie (Trans. Chem. Soc., 1905, 1339) on the modification of the ultra-violet absorption of benzene by the introduction of a nitro group.

In any case, our result would appear to supply the first direct experimental proof that other configurations of the separate benzene molecule may exist than the plane (Kekulé) type. For the great majority of chemists, who also recognise the merits of the Kekulé formula, or some modification of it, this will involve the acceptance of some dynamic conception, such as, for example, has been advocated by Collie and by Bloch. It will be noted that one phase of Bloch's formula corresponds closely to that deduced by Sir William Bragg from his observations on the diamond and on naphthalene and its derivatives.

It should perhaps be pointed out that the above suggestions depend for their validity on the assumption that the relationship between the isomerides is stereochemical in the ordinary sense. There is always a possibility, which, however, will perhaps be generally considered remote, that the difference may be rather one of structure, in that the two compounds contain, for example, different types of nuclei.

J. KENNER.

The University, Sheffield, April 21, 1922.

The Speed of Light.

IN a discussion in NATURE last year (March 10, vol. 107, p. 42) Majorana's experiment was cited as direct proof that the velocity of light is independent of the motion of the source. In reality, however, there is a disadvantage in his method which seems to the writer very greatly to lessen the value of his results.

Majorana measured the wave-length of the green light from a moving mercury-vapour tube by means of a Michelson interferometer, and detected the change of wave-length that is required by the usual Doppler theory (*Phil. Mag.*, 37, p. 145, 1919). Now it is easily seen that the frequency of the waves arriving at the receiving apparatus will undergo the usual Doppler change whether the speed of propagation is altered (moderately) or not, and speed equals wave-length times frequency, hence Majorana concludes that the speed of the light from his tube was the same when the tube was moving as when it was at rest. But obviously he measured the wave-length only after the light had suffered one or two reflections or transmissions in stationary apparatus, and its velocity might easily have been altered by these processes. Any conclusion from his results must therefore rest, at best, upon very indirect reasoning.

We may freely admit that a satisfactory emission theory consistent with all the facts that are known today, including Majorana's result, would be difficult to construct. Yet it does seem regrettable that we have still no simple direct proof of the second postulate of Relativity.